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ABSTRACT

A mathematical competencies test was given to adult college students. Mean test scores on the mathematical competencies test were compared for the categories of age, sex, occupation, mathematical background and number of years since a mathematics course was taken. Findings indicated that age, sex and mathematical course background of the adult student were characteristics which influenced mean test scores. Findings also indicated that employed students attained a significantly higher mean score on the mathematical competency test. Comparison of competency categories revealed that adult students attained higher scores on questions involving mathematical reasoning and graphing and lower scores on topics of geometry and probability and statistics. (Author)

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An Analysis of Selected Characteristics of Adult College Students in Relation to Mathematical Competencies

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An Analysis of Selected Characteristics of Adult College Students in Relation to Mathematical Competencies

Educators are increasingly interested in a return to the basics. In the field of mathematics, particularly, the aspiration is for all persons in society to have a working knowledge of basic mathematical competencies (2, 4, 5).

The basic competencies needed by enlightened citizens at any given time are determined by the needs of society at that time. The identification of basic skills in mathematics is, however, a process which should be continually updated to reflect new and changing needs. In our modern world, the number of occupations requiring a knowledge of technology and an ability in mathematics has increased. Adults wishing to qualify for employment in many fields, must have the mathematical skills and competencies required of individuals employed in those occupations (5, 7, 9).

The process of determining the mathematical competencies needed by society at any given time involves as assessment of adults and their needs at the time. A brief historical review of the circumstances leading to the list of competencies used for this study and the effect of adults in determing this list of competencies would be fitting at this time.

Earlier interest in adults and mathematical competencies was expressed during the World War II years, when military service recruits were tested during basic training (15). The poor scores on the mathematical portions of these tests aroused interest from

educators, and in particular, interest of the National Council of Teachers of Mathematics (NCTM). A group from the NCTM sought to form a Committee on Post-War Plans to review mathematical curriculum and to further set the direction of mathematical curriculum for the post-war years (13, 14, 15). The results of the Committee on Post-War Plans was a list of twenty-nine questions which answered both the needs of military and industry. The list is summarized in Table 1.

Insert Table 1 about here

Since that time, many changes have been introduced into mathematics. In the 1950's, for example, the secondary and elementary school curriculum underwent drastic changes. New concepts appeared in textbooks and new approaches to teaching old concepts found their way into the classroom. New competencies and skills were required for the day-to-day activities of the individual. Members of the NCTM, again found themselves with a challenge to define what might be considered the minimal mathematical competencies which are needed by enlightened citizens in comtemporary society. The result of the NCTM Committee on Basic Mathematical Competencies and Skills was a list of forty-eight competencies (7). These competencies are summarized into ten competency categories in Table 2.

Insert Table 2 about here

The forty-eight competencies from the previous NCTM report (1972) have been translated into a competency test by Milton W. Beckmann and Jack L. Beal (3). The Beckmann-Beal Mathematical Competencies Test for Enlightened Citizens contains forty-eight competencies. The Lackmann-Beal Mathematical Competencies Test was the instrument used for testing in this study.

Problem

The purpose of this study was to assess mathematical competencies of adult college students and to determine whether the variables of age, sex, occupation, mathematical background, and years away from a formal mathematics course were factors that affect mathematical test scores.

With the above factors in mind, the following exploratory questions were asked.

1. What is the level of mathematical competence for adult college students?

2. Are adult college students equally proficient in all categories of competence?

3. Which characteristics of adult college students influence mean test scores on the mathematical competency test?

Procedures

A sample of 261 adult students attending the University of Nebraska at Omaha were involved in the study. An adult student

was defined to be "any student who was twenty-one years of age or older, who had a lapse of three or more years in his education, and who was enrolled in a credit or non-credit course at the University".

Each student involved in the study was given the Beckmann-Beal Mathematical Competencies Test (3), and each student was asked to give information regarding age, sex, occupation, mathematical background, and number of years since a formal mathematics course was taken.

Results from the Beckmann-Beal Mathematical Competencies Test provided a test score for each participant. Using the mathematical test scores, each of the variables of age, sex, occupation, mathematical background, and years away from a mathematics course was tested separately. Statistical tests included a two-sample t-test and a one-way analysis of variance test (11). A further test was performed to determine any differences between mean scores for the ten competency categories. The test used for this purpose was the Pearson-Chi-Square Test (11).

Results from the Study

1. Mean Test Scores on the Beckmann-Beal Mathematical Competencies Test

Adult college students involved in the study attained a mean score of 36.9 out of 48 (76.8%) total points on the mathematical competencies test. Scores ranged from 8 to 48 with the standard deviation for the total population being 6.9.

2. Competency Categories

The ten competency categories have been presented previously in Table 2. Findings of this study indicated that categories with the highest scores for adult college students were categories of "mathematical reasoning" (88.3%) and "graphing" (83.6%). The two competency categories with lowest adult student scores were categories of "probability and statistics" (59.7%) and "geometry" (69.8%).

To test for any difference in mean test scores for the ten competency categories, the Pearson Chi-Square Test for Independence was used (10). The results of the Chi-Square Test are given in Table 3.

Insert Table 3 about here

The expected frequency "e_j" was calculated by using the mean percentile score (76.8%) times the number of possible responses in each competency category. The results of the Chi-Square Test were found to be statistically significant (.001) for competency categories.

3. Age

The ages of participants were divided into groups of five-year spans beginning with age twenty-one, as indicated in Table 4.

Insert Table 4 about here

Results from the study indicate that the group with the highest mean test scores is the oldest group in the study, while the 41-45 year old group has the poorest mathematical scores. Both the two-sample t-test and the one-way analysis of variance test indicated there was a significant (.01) difference between age groups with regard to mathematical test scores.

4. Sex

Of the 261 participants involved in this study, 131 were male and 130 were female. Findings from Table 5 indicate a significant difference (.05) between male and female participant scores on the mathematical competencies test.

Insert Table 5 about here

5. Occupation

All participants in the study were asked to indicate whether they were employed, either full-time or part-time. Those students who were employed were asked to list their exact job titles. The job titles were categorized using the Occupational Outlook Handbook (17). Results of the mathematics scores for each occupation group are presented in Table 6.

Insert Table 6 about here

Findings from the study indicate that group with the highest mean scores on the mathematical competencies test was the education group, while the lowest mean scores were attained by the health/social service group. Results from both the two-sample t-test and the one-way analysis of variance test indicated no significant differences among occupation groups for mean scores on the mathematical competency test, but employed participants attained a statistically significantly (.05) higher mean score than unemployed participants, as indicated in Table 6.

6. Mathematical Background

Each particpant was asked to list the highest level mathematics course completed, either in high school or in college. The mathematics courses were listed in order of difficulty. Findings revealed that more than one-third of the adult students listed high school algebra as their highest level mathematical course, while more males than female participants had taken courses in statistics and calculus. The results the mathematical backgrounds for participants in the study is given in Table 7.

Insert Table 7 about here

Findings from the study indicate that the group with a mathematics background which includes calculus has the highest mean score. Results of the statistical tests indicated there was a significant difference (.01) between mathematical background with

regard to mean test scores.

8. Years Away from a Mathematics Course

Each participant in the study was asked to indicate the number of years since a formal mathematics course was taken. The number of years was grouped in categories of ten-year interval. The results of the findings on this topic are listed in Table 8.

Insert Table 8 about here

Results from the study indicate that the group of adult students who had their last mathematics course more than thirty years ago had the highest mean score. Results from the statistical tests revealed no significant difference among time-intervals with regard to mean scores on the mathematical competency test.

Final Conclusions

1. In this study, it was found that the mean score on the mathematical competency test was 36.9 out of 48 (76.8%).

As a basis of comparison, other studies which used the Beckmann-Beal Mathematical Competencies Test are cited. Cramer (6), testing Nebraska high school seniors found a mean score of 38.1 (78.1%), Neimann (12) found a mean score of 27.2 (68.8%) for ninth graders in Nebraska. A third study Stones (17), testing students enrolled in pre-calculus courses in Nebraska colleges, found a mean score of 35.7 (74.3%).

2. Statistical testing revealed that there was a significant difference (.001) among competency categories with respect to mean scores on the mathematical competency test. The differences indicated best scores on the categories of "reasoning" and "graphing" and poorer scores on the categories of "probability and statistics" and "geometry" (Table 3).

In comparison, Cramer (6) found much the same results for high school seniors: highest scores for "mathematical reasoning" (72.3%) and "graphing" (72.0%), and lowest scores for "probability and statistics" (33.5%) and "geometry" (58.5%). Results from the National Assessment of Educational Progress Report (NAEP) (5) indicated that adults performed well on topics of "graphing" and "consumer word problems" but adults did poorly on "area and perimeter problems".

3. Statistical testing from this study revealed there were significant differences (.01) among age groups with regard to mean test scores on the mathematical competency test. The difference favored students in the 51+ age group and the 36-50 age group (Table 4).

A study by McCants (11) revealed a contrary result. She found that mathematical achievement was not dependent on the age of the adult student.

4. Findings from this study revealed that there was a significant difference (.05) between male and female participants with respect to mean test scores on the mathematical competency test. The difference favored the male participants (Table 5).

As a comparison, Cramer (6), Stones (16) and the NAEP 1973 study (5) found that mathematical achievement was dependent on sex, while Fennema (8) and Bailey (1) stated that sex was not a significant factor in determining mathematical achievement.

5. Statistical testing from this study revealed there were significant differences (.01) among mathematical background groups with respect to mean test scores on the mathematical competency test. The differences favored the groups with background in higher level mathematics courses (Table 7).

In agreement, Cramer (6), Stones (16), and McCants (11) stated that mathematical background was a factor which influenced scores on mathematical competency tests.

6. Findings from this study revealed there were no significant differences among occupation groups with respect to mean test scores on the mathematical competency test (Table 6).

7. Findings from this study revealed there were no significant differences among groups categorized by years since a mathematics course was taken (Table 8).

In agreement with this result, McCants (11) testing adult students found that years since a mathematics course was taken was not a factor which affected the results on a mathematics test.

Discussion

Results from this study would suggest that adult students have a knowledge of mathematical competencies which is equal to or superior to the knowledge of high school students. Also it would

appear that the more mathematics that is studied by a person, the better he/she will score on a mathematical competencies test.

This study brought out the fact that employed persons scored higher on the mathematical competencies test than unemployed persons. This fact might be used as a possible answer to the question often asked by students: "When will I use this math?"

Two problems seem to emerge which would bear additional discussion. The first of these is the poor scores obtained on the mathematical competencies test in the fields of "geometry" and "probability and statistics". These topics are recent additions to the curriculum of elementary and middle school mathematics. Many adults have had no formal course work in either area and some school teachers may not have studied these topics. If an enlightened citizen is to have knowledge of "geometry" and "probability and statistics", it is imperative that the courses be included in the elementary school and that elementary school teachers be well versed in presenting these topics. This may entail extra summer work for some teachers whose prior education did not include these topics.

The second problems which emerges from this study is the lower scores for women students on the mathematical competency test. In the past, women have been discouraged from enrolling in mathematics courses, and from exploring careers in technical fields. In the modern world, new mathematically related fields are opening for all persons. Female students need to be encouraged by their teachers to enroll in mathematics courses at all levels. Only

then can women be assured of the mathematical backgrounds necessary to pursue these recently opening careers.

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Table 1. Topics Mastered by the Mathematically Literate Person - Commission on Post-War Plans

Computation with Whole numbers, common fractions, decimals, percents, and signed numbers

Estimation and significant figures

Measurements, the metric system, and conversion

Tables, graphs, maps, and blueprints

Basic geometric definitions and constructions

Sine, cosine, tangent, and the 3-4-5 relation

Square root

Addition of vectors

Basic algebraic symbolism and common formulas

Ratio, proportion, and similar triangles

Axioms, hypotheses, and conclusions

Elementary statistics, business and consumer arithmetic

Table 2. Mathematical Competencies and Skills Essential for Enlightened Citizens - Committee on Basic Mathematical Competencies and Skills

Categories of Competence
1. Numbers and numerals
2. Operations and properties
3. Mathematical sentences
4. Geometry
5. Measurement
6. Relations and functions
7. Probability and statistics
8. Graphing
9. Mathematical reasoning
10. Business and consumer mathematics

Table 3. Chi-Square Test for Competency Categories

Competency Category	Frequency b_j	Expected Frequency e_j	$\frac{(b_j - e_j)^2}{e_j}$
1. Numbers and numerals	1448	1403	1.443
2. Operations and properties	1699	1603	5.749
3. Mathematical sentences	553	601	3.834
4. Geometry	911	1002	8.264
5. Measurement	934	1002	4.615
6. Relations and functions	622	601	.733
7. Probability and statistics	617	802	42.675
8. Graphing	873	802	6.286
9. Mathematical reasoning	668	601	7.469
10. Business and consumer math	1263	1202	3.096
			84.164

*$\chi^2 < .001$

Table 4. Comparison of Test Scores by Age

	Age	x	A_1	A_2	A_3	A_4	A_5	A_6	A_7
A_1	21-25 years	34.508		-3.259**	-2.025*	-2.749**	.243	-.413	-2.837**
A_2	26-30	38.123			.519	-.825	3.457**	1.013	-2.301*
A_3	31-35	37.524				-1.017	1.632	.592	-2.109*
A_4	36-40	39.154					2.399*	1.332	-1.649
A_5	41-45	33.933						-.527	-2.814**
A_6	46-50	35.857							-2.338*
A_7	51+	42.556							

* $t < .05$

** $t < .01$

Table 5. Comparison of Test Scores by Sex

	Sex	$\bar{x}$	S_1	S_2
S_1	Male	37.669		1.862*
S_2	Female	36.022		

*t < .05

Table 6. Comparison of Test Scores by Occupation

	Occupation	$\bar{x}$	O_1	O_2	O_3	O_4	O_5	O_6	O_7	O_8
O_1	Industry/Transportation	38.800		1.520	1.004	-1.151	1.722*	.341	1.364	1.929*
O_2	Sales/Service	35.436			-.601	2.373*	.157	1.568	.361	-.149
O_3	Government	36.731				-2.216*	.794	-.932	.312	.667
O_4	Education	41.200					3.286**	1.750*	2.474**	3.221**
O_5	Health/Social Service	35.056						-1.806*	-.525	-.363
O_6	Office	38.238							1.369	2.013*
O_7	Student	36.139								.313
O_8	Housewife	35.679								

			O_9	O_{10}
O_9	Employed	37.582		
O_{10}	Unemployed	35.865	1.717*	

* $t < .05$

** $t < .01$

Table 7. Comparison of Test Scores by Mathematics Background

	Mathematics Background	$\bar{x}$	M_1	M_2	M_3	M_4	M_5	M_6	M_7
M_1	General/Business Math	31.553		-2.283**	-2.823**	-2.756	-4.669	-5.428**	-6.779**
M_2	High School Algebra	35.242			-.464	-.626	-2.956**	-3.596**	-5.487**
M_3	Geometry	35.863				-.244	-3.046**	-3.660**	-5.741**
M_4	College Algebra	36.188					-3.019**	-3.489**	-6.145**
M_5	Trigonometry	40.364						-.299	-4.705**
M_6	Statistics	40.767							-2.349*
M_7	Calculus	43.440							

* $t < .05$

** $t < .01$

Table 8. Comparison of Test Scores by Years Away from Mathematics

	Year Away		Y_1	Y_2	Y_3	Y_4
Y_1	$0 \leq x \leq 10$	36.891		-.240	1.147	-.213
Y_2	$10 < x \leq 20$	36.891			1.425	.147
Y_3	$20 < x \leq 30$	35.037				.842
Y_4	$x < 30$	37.444				